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OILED WRAPPERS, OILS AND WAXES IN THE CONTROL OF APPLE SCALD

BY

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(Contribution from Bureau of Plant Industry)

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OILED WRAPPERS, OILS AND WAXES IN THE CONTROL OF APPLE SCALD[1]

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INTRODUCTION

It has been pointed out in earlier publications[2] that apple scald could be partly or entirely controlled by the application of various oils, fats, and waxes, either to the apple wrappers or to the apples themselves. The present paper reports the results of more complete and detailed studies on the relation of oils and waxes to the behavior of apples in storage.

STORAGE EXPERIMENTS WITH WRAPPERS

The results of five years' experiments with various kinds of wrappers are reported in Table I. It will be noted that the tests were made in various sections of the country and on varieties that are particularly susceptible to scald. The northwestern apples were mostly from the fancy grade and the eastern ones from the early pickings and greener lots. The eastern apples were packed in barrels and the northwestern ones in boxes and all were held in the local commercial storage plants, usually at a temperature of 32°. Unless otherwise stated they were wrapped on the date of picking and placed immediately in cold storage.

The scald values given show the general severity of the disease, allowance being made for the surface area scalded and the intensity of the scald, as well as the number of apples affected. Scald was not usually evident when the apples were removed from storage, but developed rapidly as the fruit became warm. The percentages of scald reported for eastern apples are based upon the condition of the fruit after being held for 3 days at 70° F., and those for northwestern apples on the condition of the fruit after 7 to 10 days at 55° to 60° F. In most cases the apples were held for later notes, the contrast between the fruit in the oiled wrappers and that in untreated wrappers becoming greater with the extension of the after storage period.

TABLE I.—*The effect of oil, paraffin, and other wrappers upon the development of scald*

Variety, locality of orchard, date of picking, and kind of wrapper.	Percentage of scald on dates shown by numbers in parentheses.						
	December.	January.	February.	March.	April.	May.	June.
EASTERN APPLES.							
Grimes Golden, Vienna, Va., Sept. 18, 1918	.....	(20)	.....	.....	.....	.....	.....
Unwrapped	.....	38	.....	.....	.....	.....	.....
Unoiled wrapper	.....	27	.....	.....	.....	.....	.....
Paraffin wrapper No. 1	.....	18	.....	.....	.....	.....	.....
Paraffin wrapper No. 2	.....	23	.....	.....	.....	.....	.....
Paraffin wrapper No. 3	.....	15	.....	.....	.....	.....	.....
Mineral oil wrapper No. 1a	.....	0	.....	.....	.....	.....	.....

[1] Accepted for publication Oct. 22, 1923.

[2] BROOKS, Charles, COOLEY, J. S., and FISHER, D. F. APPLE SCALD. *In* Jour. Agr. Research, v. 16, p. 195–217, 11 fig. 1919.

———— ———— ————. NATURE AND CONTROL OF APPLE SCALD. *In* Jour. Agr. Research, v. 18, p. 211–240, 2 fig. 1919. Literature cited, p. 240.

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TABLE I.—*The effect of oil, paraffin, and other wrappers upon the development of scald*—Continued

Variety, locality of orchard, date of picking, and kind of wrapper.	Percentage of scald on dates shown by numbers in parentheses.						
	December.	January.	February.	March.	April.	May.	June.
EASTERN APPLES—continued.							
Grimes Golden, Rockville, Md., Sept. 4, 1919	(31)	(13)					
Unwrapped	64	70					
Unoiled wrapper	80	83					
Glassine wrapper	35						
Paraffin wrapper No. 1	37	60					
Paraffin wrapper No. 2	16						
Mineral oil wrapper No. 1	0	0					
Mineral oil wrapper No. 1a	0						
Mineral oil wrapper No. 1b	0	0					
Mineral oil wrapper No. 2	0						
Mineral oil wrapper No. 3	0	0					
Grimes Golden, Arlington, Va., Sept. 10, 1920		(8)	(3)				
Unwrapped		3	15				
Mineral oil wrapper No. 3		0	0				
Mineral oil wrapper No. 3a		0	0				
Grimes Golden, Rockville, Md., Sept. 3, 1920	(18)	(8)					
Unwrapped	10	45					
Unoiled wrapper	12	66					
Mineral oil wrapper No. 3	0	0					
Mineral oil wrapper No. 4	0	0					
Grimes Golden, Charlestown, W. Va., Sept. 6, 1921		(19)			(13)		
Unwrapped		35			70		
Mineral oil wrapper No. 3a		0			0		
Mineral oil wrapper No. 4		0			15		
Mineral oil wrapper No. 4b		0			18		
Mineral oil wrapper No. 4c		30			38		
Mineral oil wrapper No. 5		2			22		
Mineral oil wrapper No. 6		0			20		
Mineral oil wrapper No. 7		0			6		
Grimes Golden, Rockville, Md., Sept. 6, 1922	(22)	(12)					
Unwrapped	40	49					
Unoiled wrapper		42					
Mineral oil wrapper No. 3a	0	1					
Mineral oil wrapper No. 10		3					
Mineral oil wrapper No. 11		1					
Mineral oil wrapper No. 11a		0					
Mineral oil wrapper No. 11b		0					
Mineral oil wrapper No. 11c		0					
Mineral oil wrapper No. 11d		2					
Mineral oil wrapper No. 11e		2					
Mineral oil wrapper No. 13		1					
York Imperial, Rockville, Md., Sept., 26, 1919		(15)		(5)			
Unwrapped		70					
Glassine wrapper		50					
Mineral oil wrapper No. 1		0		0			
Mineral oil wrapper No. 1b		0		0			
Mineral oil wrapper No. 2		0					
Mineral oil wrapper No. 3		0		0			
Wrappers with 60 per cent oil and 40 per cent paraffin mixture		0					
York Imperial, Leesburg, Va., Nov. 1, 1919		(17)					
Unwrapped		74					
Unoiled wrapper		69					
Mineral oil wrapper No. 1		4					
As above but 60 per cent oil and 40 per cent paraffin mixture		3					
York Imperial, Winchester, Va., Oct. 9, 1920			(1)	(5)		(14)	
Unwrapped			38	55		89	
Mineral oil wrapper No. 3a			0	0		0	
Mineral oil wrapper No. 4			0	0		0	
York Imperial, Arlington, Va., Sept. 27, 1920			(5)		(13)	(26)	
Unwrapped			45		58	84	
Unoiled wrapper			27		32	45	
Unoiled medicated wrapper			50			83	
Mineral oil wrapper No. 3			0		0	7	
Mineral oil wrapper No. 3a			0		0	3	
Mineral oil wrapper No. 4			0		1	7	

TABLE I.—*The effect of oil, paraffin, and other wrappers upon the development of scald*—Continued

Variety, locality of orchard, date of picking, and kind of wrapper.	Percentage of scald on dates shown by numbers in parentheses.						
	December.	January.	February.	March.	April.	May.	June.
EASTERN APPLES—continued.							
York Imperial, Charlestown, W. Va., Sept. 20, 1921			(10)				
Unwrapped			16				
Unoiled wrapper			8				
Mineral oil wrapper No. 3			0				
Mineral oil wrapper No. 3a			0				
Mineral oil wrapper No. 4			4				
Mineral oil wrapper No. 4a			3				
Mineral oil wrapper No. 4b			3				
Mineral oil wrapper No. 4c			9				
Mineral oil wrapper No. 5			6				
Mineral oil wrapper No. 6			1				
Mineral oil wrapper No. 7			2				
York Imperial, Arlington, Va., Sept. 12, 1922		(29)					
Unwrapped		65					
Mineral oil wrapper No. 3a		5					
York Imperial, Rockville, Md., Oct. 2, 1922			(17)		(23)		
Unwrapped			40		70		
Unoiled wrapper			31		67		
Mineral oil wrapper No. 3a			0		4		
Mineral oil wrapper No. 10			1		5		
Mineral oil wrapper No. 11			0		5		
Mineral oil wrapper No. 11a			2		12		
Mineral oil wrapper No. 13			0		8		
York Imperial, Woodside, Del., Sept. 21, 1922			(6)	(26)			
Unwrapped			25	46			
Unoiled wrapper			—	40			
Mineral oil wrapper No. 3a			—	2			
Mineral oil wrapper No. 11			—	7			
Mineral oil wrapper No. 11a			—	4			
Mineral oil wrapper No. 11b			—	6			
Mineral oil wrapper No. 11c			—	8			
Mineral oil wrapper No. 11d			—	15			
Mineral oil wrapper No. 11e			—	9			
Mineral oil wrapper No. 11f			—	15			
Mineral oil wrapper No. 13			—	6			
Mineral oil wrapper No. 13a			—	15			
York Imperial, Cornelia, Ga., Sept. 8, 1922				(5)			
Unwrapped				45			
Mineral oil wrapper No. 3a				0			
Stayman Winesap, Winchester, Va., Sept. 29, 1920		(6)	(1)	(5)		(14)	
Unwrapped		2	18	25		34	
Unoiled wrapper						26	
Unoiled medicated wrapper						31	
Mineral oil wrapper No. 3		0	0	0		0	
Mineral oil wrapper No. 3a		0	0	0		0	
Mineral oil wrapper No. 4		0	0	0		0	
Stayman Winesap, Rockville, Md., Oct. 7, 1920			(24)				
Unwrapped			25				
Mineral oil wrapper No. 3			0				
Mineral oil wrapper No. 3a			0				
Stayman Winesap, Charlestown, W. Va., Sept. 21, 1921			(13)				
Unwrapped			52				
Mineral oil wrapper No. 3a			4				
Mineral oil wrapper No. 4			16				
Mineral oil wrapper No. 4a			9				
Mineral oil wrapper No. 4b			10				
Mineral oil wrapper No. 4c			22				
Stayman Winesap, Woodside, Del., Sept. 28, 1922			(6)	(26)			
Unwrapped			15	53			
Unoiled wrapper			—	22			
Tin foil			—	72			
Mineral oil wrapper No. 3a			—	2			
Mineral oil wrapper No. 11			—	10			
Mineral oil wrapper No. 11a			—	9			
Mineral oil wrapper No. 13			—	8			

TABLE I.—*The effect of oil, paraffin, and other wrappers upon the development of scald*—Continued

Variety, locality of orchard, date of picking, and kind of wrapper.	Percentage of scald on dates shown by numbers in parentheses.						
	December.	January.	February.	March.	April.	May.	June.
EASTERN APPLES—continued.							
Arkansas (Mammoth Black Twig), Winchester, Va., Oct. 7, 1919		(10)	(2)	(23)			
Unwrapped		55	64	78			
Unoiled wrapper		38	59	76			
Mineral oil wrapper No. 1a		0	18	31			
Mineral oil wrapper No. 1		1	25	30			
As above but 60 per cent oil and 40 per cent paraffin mixture			16	31			
Arkansas (Mammoth Black Twig), Rockville, Md., Oct. 14, 1920			(24)			(26)	
Unwrapped			45			72	
Unoiled wrapper			48				
Mineral oil wrapper No. 3			0			4	
Mineral oil wrapper No. 3a			0			1	
Mineral oil wrapper No. 4			2				
Arkansas (Mammoth Black Twig), Middletown, Va., Oct. 20, 1920		(24)	(14)				
Unwrapped		32	51				
Mineral oil wrapper No. 3		0	0				
Mineral oil wrapper No. 3a		0	0				
Arkansas (Mammoth Black Twig), Winchester, Va., Oct. 18, 1920		(13) (24)				(26)	
Unwrapped		35 40				60	
Mineral oil wrapper No. 4		— 8				8	
Arkansas (Mammoth Black Twig), Rockville, Md., Oct. 5, 1922			(17)		(23)		
Unwrapped			75		90		
Mineral oil wrapper No. 3a			18		25		
Mineral oil wrapper No. 11a			22		30		
Mineral oil wrapper No. 11b			18		37		
Mineral oil wrapper No. 11c			21		35		
Mineral oil wrapper No. 11d			27		45		
Mineral oil wrapper No. 11e			18		50		
Mineral oil wrapper No. 11f			25		50		
Mineral oil wrapper No. 12			21		40		
Mineral oil wrapper No. 13			22		40		
Arkansas (Mammoth Black Twig), Martinsburg, W. Va., Oct. 26, 1922			(6) (21)		(23)		
Unwrapped			40 70		93		
Mineral oil wrapper No. 3a			— 1		15		
Mineral oil wrapper No. 11			— 7		18		
Mineral oil wrapper No. 11a			— 10		15		
Mineral oil wrapper No. 11b			— 6		19		
Mineral oil wrapper No. 11c			— 2		15		
Mineral oil wrapper No. 12			— 2		10		
Mineral oil wrapper No. 13			— 8		12		
Mineral oil wrapper No. 13a			— 1		10		
Yellow Newtown, Winchester, Va., Sept. 30, 1919				(1)	(12)		(12)
Unwrapped				0	15		78
Mineral oil wrapper No. 1				0	0		0
Mineral oil wrapper No. 1b				0	0		0
Mineral oil wrapper No. 2				0	0		0
Mineral oil wrapper No. 3				0	0		0
Rhode Island, Greening, Penn Yan, N. Y., Oct. 7, 1920			(15)	(19)			
Unwrapped			2	21			
Mineral oil wrapper No. 3			0	0			
Mineral oil wrapper No. 3a			0	0			
Mineral oil wrapper No. 4			0	0			
Rhode Island, Greening, Poughkeepsie, N. Y., Oct. 4, 1921				(29)			
Unwrapped				28			
Mineral oil wrapper No. 3a				0			
Mineral oil wrapper No. 3b				7			
Mineral oil wrapper No. 4				0			
Mineral oil wrapper No. 4b				2			
Mineral oil wrapper No. 4c				11			
Mineral oil wrapper No. 6				0			
Mineral oil wrapper No. 9				3			
NORTHWESTERN APPLES.							
Grimes Golden, Wenatchee, Wash., Sept. 24, 1919			(5)				
Unoiled wrapper			15				
Mineral oil wrapper No. 1			0				

TABLE I.—*The effect of oil, paraffin, and other wrappers upon the development of scald*—Continued

Variety, locality of orchard, date of picking, and kind of wrapper.	Percentage of scald on dates shown by numbers in parentheses.						
	December.	January.	February.	March.	April.	May.	June.
NORTHWESTERN APPLES—continued.							
Grimes Golden, Wenatchee, Wash., Sept. 20, 1920:							
Delayed in closed room till Oct. 14, 1920			(12)				
Unoiled wrapper			57				
Mineral oil wrapper No. 1			1				
Mineral oil wrapper No. 4			1				
Immediate storage—							
Unwrapped			7				
Unoiled wrapper			25				
Unoiled medicated wrapper			8				
Mineral oil wrapper No. 1			0				
Mineral oil wrapper No. 3a			0				
Mineral oil wrapper No. 4			0				
Grimes Golden, Wenatchee, Wash., Sept. 19, 1921				(1)			
Cellar storage—							
Unoiled wrapper				34			
Mineral oil wrapper No. 4				0			
Mineral oil wrapper No. 4b				0			
Mineral oil wrapper No. 8				0			
Cold storage—							
Unoiled wrapper				31			
Unoiled medicated wrapper				22			
Mineral oil wrapper No. 4				0			
Mineral oil wrapper No. 4b				0			
Mineral oil wrapper No. 4c				1			
Mineral oil wrapper No. 5				0			
Mineral oil wrapper No. 6				0			
Mineral oil wrapper No. 7				0			
Grimes Golden, Wenatchee, Wash., Sept. 13, 1922			(17)				
Cellar storage—							
Unoiled wrapper			54				
Unoiled medicated wrapper			14				
Mineral oil wrapper No. 4			1				
Mineral oil wrapper No. 7			1				
Mineral oil wrapper No. 12			1				
Mineral oil wrapper No. 13a			3				
Cold storage—							
Unoiled wrapper			36				
Unoiled medicated wrapper			14				
Mineral oil wrapper No. 4			1				
Mineral oil wrapper No. 6			1				
Mineral oil wrapper No. 7			0.5				
Mineral oil wrapper No. 11c			0				
Mineral oil wrapper No. 11f			0				
Mineral oil wrapper No. 12			0.4				
Mineral oil wrapper No. 13			0.7				
York Imperial, Wenatchee, Wash., Oct. 8, 1921					(22)		
Unoiled wrapper					47		
Unoiled medicated wrapper					25		
Mineral oil wrapper No. 3a					0		
Mineral oil wrapper No. 4					0		
Mineral oil wrapper No. 4a					1		
Mineral oil wrapper No. 4b					1		
Mineral oil wrapper No. 4c					2		
Mineral oil wrapper No. 5					1		
Mineral oil wrapper No. 6					0		
Mineral oil wrapper No. 7					0		
Mineral oil wrapper No. 9					0		
York Imperial, Wenatchee, Wash. Picked Oct. 19, 1922, stored Oct. 23, 1922					(19)		
Unoiled wrapper					51		
Mineral oil wrapper No. 4					1		
Mineral oil wrapper No. 7					1		
Mineral oil wrapper No. 11					0.5		
Mineral oil wrapper No. 11a					1		
Mineral oil wrapper No. 11c					0.5		
Mineral oil wrapper No. 11f					2		
Mineral oil wrapper No. 12					0.7		
Mineral oil wrapper No. 13a					1		

TABLE I.—*The effect of oil, paraffin, and other wrappers upon the development of scald*—Continued

Variety, locality of orchard, date of picking, and kind of wrapper.	Percentage of scald on dates shown by numbers in parentheses.						
	December.	January.	February.	March.	April.	May.	June.
NORTHWESTERN APPLES—continued.							
Rome Beauty Wenatchee, Wash., Oct. 24, 1919. Stored Oct 31					(30)		
Unoiled wrapper					41		
Mineral oil wrapper No. 1					0		
Rome Beauty, Wenatchee, Wash., Oct. 20, 1920				(21)	(29)	(18)	
Unoiled wrapper				13	25	30	
Unoiled medicated wrapper						23	
Mineral oil wrapper No. 1				0	0	0	
Mineral oil wrapper No. 3a				0	0	0	
Mineral oil wrapper No. 4				0	0	0	
Rome Beauty, Wenatchee, Wash., Oct. 27, 1921					(22)		
Cellar storage—							
Unoiled wrapper					27		
Mineral oil wrapper No. 4					0		
Mineral oil wrapper No. 4a					3		
Cold storage—							
Unoiled wrapper					22		
Mineral oil wrapper No. 4a					0		
Mineral oil wrapper No. 4b					0		
Mineral oil wrapper No. 7					0		
Rome Beauty, Wenatchee, Wash., Oct. 6, 1922. Stored Oct. 10						(25)	
Cellar storage—							
Unoiled wrapper						55	
Mineral oil wrapper No. 4						3	
Mineral oil wrapper No. 7						3	
Mineral oil wrapper No. 11						1	
Mineral oil wrapper No. 11a						3	
Mineral oil wrapper No. 12						2	
Mineral oil wrapper No. 13						2	
Cold storage—							
Unoiled wrapper						10	
Mineral oil wrapper No. 4						0.3	
Mineral oil wrapper No. 7						0.8	
Mineral oil wrapper No. 10						2	
Mineral oil wrapper No. 11						0.7	
Mineral oil wrapper No. 11a						4	
Mineral oil wrapper No. 12						2	
Mineral oil wrapper No. 13						4	
Rome Beauty, Wenatchee, Wash., Oct. 19, 1922						(4)	
Unoiled wrapper						42	
Mineral oil wrapper No. 4						0	
Mineral oil wrapper No. 12						0	
Mineral oil wrapper No. 13						0	
Stayman Winesap, Wenatchee, Wash., Oct. 12, 1918				(24)			
Unwrapped				16			
Unoiled wrapper				19			
Glassine wrapper				47			
Paraffin wrapper No. 2				17			
Paraffin wrapper No. 3				11			
Mineral oil wrapper No. 1a				0			
Stayman Winesap, Wenatchee, Wash., Nov. 4, 1920				(7)		(23)	
Unoiled wrapper				2		16	
Mineral oil wrapper No. 1				0		0	
Mineral oil wrapper No. 3a				0		0	
Mineral oil wrapper No. 4				0		0	
Staymen Winesap, Wenatchee, Wash., Oct. 10, 1921				(18)			
Cellar storage—							
Unoiled wrapper				16			
Mineral oil wrapper No. 4a				7			
Cold storage, Nov. 3, 1921—							
Unoiled wrapper				16			
Unoiled medicated wrapper				15			
Mineral oil wrapper No. 4a				2			
Mineral oil wrapper No. 4b				0			
Mineral oil wrapper No. 4c				1			
Mineral oil wrapper No. 7				0			

TABLE I.—*The effect of oil, paraffin, and other wrappers upon the development of scald*—Continued

Variety, locality of orchard, date of picking, and kind of wrapper.	Percentage of scald on dates shown by numbers in parentheses.						
	December.	January.	February.	March.	April.	May.	June.
NORTHWESTERN APPLES—continued.							
Stayman Winesap, Wenatchee, Wash., Oct. 25, 1922				(17)			
Cellar storage—							
Unoiled wrapper				9			
Mineral oil wrapper No. 7				0.5			
Mineral oil wrapper No. 12				0.1			
Mineral oil wrapper No. 13				0.1			
Cold storage—							
Unoiled wrapper				14			
Mineral oil wrapper No. 4				0			
Mineral oil wrapper No. 7				0			
Mineral oil wrapper No. 11				0.6			
Mineral oil wrapper No. 12				0			
Mineral oil wrapper No. 13				0			
Stayman Winesap, Wenatchee, Wash., Oct. 20, 1922						(4)	
Unoiled wrapper						24	
Mineral oil wrapper No. 4						0	
Mineral oil wrapper No. 11						0	
Mineral oil wrapper No. 12						0	
Mineral oil wrapper No. 13						0	
Delicious, Wenatchee, Wash., Sept. 29, 1921				(17)			
Cellar storage—							
Unoiled wrapper				3			
Mineral oil wrapper No. 4				0			
Mineral oil wrapper No. 4b				0			
Cold storage—							
Unoiled wrapper				6			
Mineral oil wrapper No. 4				0			
Mineral oil wrapper No. 4a				1			
Mineral oil wrapper No. 4b				0			
Mineral oil wrapper No. 7				0			
Arkansas (Mammoth Black Twig), Wenatchee, Wash., Nov. 1, 1920						(17)	
Unoiled wrapper						23	
Mineral oil wrapper No. 1						0	
Mineral oil wrapper No. 3a						0	
Mineral oil wrapper No. 4						0	
Arkansas (Mammoth Black Twig), Wenatchee, Wash., Oct. 25, 1921							(7)
Unoiled wrapper							18
Mineral oil wrapper No. 4							6
Mineral oil wrapper No. 4b							5
Mineral oil wrapper No. 4c							7
Mineral oil wrapper No. 5							4
Mineral oil wrapper No. 7							11
Mineral oil wrapper No. 8							4
Mineral oil wrapper No. 9							5
Arkansas (Mammoth Black Twig), Wenatchee, Wash., Nov. 2, 1922. Stored Nov. 7							(6)
Cellar storage—							
Unoiled wrapper							49
Mineral oil wrapper No. 4							15
Mineral oil wrapper No. 7							16
Mineral oil wrapper No. 12							7
Mineral oil wrapper No. 13							8
Cold storage							
Unoiled wrapper							45
Mineral oil wrapper No. 4							5
Mineral oil wrapper No. 7							7
Mineral oil wrapper No. 10							0
Mineral oil wrapper No. 12							0
Mineral oil wrapper No. 13							5
White Pearmain, Wenatchee, Wash., Oct. 4, 1921							(7)
Unoiled wrapper							29
Mineral oil wrapper No. 4							0
Mineral oil wrapper Nol 4a							3
Mineral oil wrapper Nol 4b							0
Mineral oil wrapper No. 4c							6
Mineral oil wrapper No. 6							0
Mineral oil wrapper No. 7							0

TABLE I.—*The effect of oil, paraffin, and other wrappers upon the development of scald*—Continued

Variety, locality of orchard, date of picking, and kind of wrapper.	Percentage of scald on dates shown by numbers in parentheses.						
	December.	January.	February.	March.	April.	May.	June.
NORTHWESTERN APPLES—continued.							
White Pearmain, Wenatchee, Wash., Oct. 12, 1922					(3)		
Unoiled wrapper					12		
Mineral oil wrapper No. 4					0		
Mineral oil wrapper No. 7					0		
Mineral oil wrapper No. 11					0		
Mineral oil wrapper No. 11a					0		
Mineral oil wrapper No. 12					0		
Mineral oil wrapper No. 13					0		
Arkansas Black, Wenatchee, Wash., Oct. 21, 1920							(20)
Unoiled wrapper							9
Mineral oil wrapper No. 1							0
Mineral oil wrapper No. 3a							0
Mineral oil wrapper No. 4							0
Arkansas Black, Wenatchee, Wash., Oct. 25, 1921							(14)
Unoiled wrapper							7
Mineral oil wrapper No. 4							0
Mineral oil wrapper No. 4a							1
Mineral oil wrapper No. 4b							0
Mineral oil wrapper No. 4c							2
Arkansas Black, Wenatchee, Wash., Picked Nov. 4, 1922, stored Nov. 7							(8)
Cellar storage—							
Unoiled wrapper							18
Mineral oil wrapper No. 4							0.2
Mineral oil wrapper No. 7							0
Mineral oil wrapper No. 12							0
Mineral oil wrapper No. 13							0
Cold storage—							
Unoiled wrapper							5
Mineral oil wrapper No. 7							0
Mineral oil wrapper No. 12							0
Mineral oil wrapper No. 13							0
Yellow Newtown, Wenatchee, Wash., Oct. 21, 1921							(14)
Unoiled wrapper							33
Mineral oil wrapper No. 4							8
Mineral oil wrapper No. 4a							3
Mineral oil wrapper No. 4b							3
Mineral oil wrapper No. 4c							2
Winesap, Wenatchee, Wash., Oct. 25, 1920							(20)
Unoiled wrapper							9
Mineral oil wrapper No. 3a							0
Mineral oil wrapper No. 4							0
Winesap, Wenatchee, Wash., Oct. 13, 1921. Cellar storage						(20)	
Unoiled wrapper						6	
Mineral oil wrapper No. 4						0	
Mineral oil wrapper No. 4a						1	
Mineral oil wrapper No. 4b						0	
Mineral oil wrapper No. 4c						0	
Mineral oil wrapper No. 5						0	
Mineral oil wrapper No. 7						0	
Mineral oil wrapper No. 8						0	
Winesap, Wenatchee, Wash., Oct. 25, 1921. Cold storage							(14)
Unoiled wrapper							30
Mineral oil wrapper No. 3a							0
Mineral oil wrapper No. 4							9
Mineral oil wrapper No. 4a							0
Mineral oil wrapper No. 4b							0
Mineral oil wrapper No. 4c							3
Mineral oil wrapper No. 5							0
Mineral oil wrapper No. 6							0
Mineral oil wrapper No. 7							0
Mineral oil wrapper No. 8							0
Mineral oil wrapper No. 9							0
Winesap, Wenatchee, Wash., Oct. 19, 1922						(26)	
Unoiled wrapper						6	
Mineral oil wrapper No. 4						0	
Mineral oil wrapper No. 7						0	
Mineral oil wrapper No. 11						0	
Mineral oil wrapper No. 12						0	
Mineral oil wrapper No. 13						0	

UNOILED WRAPPERS

The tests with apples in the usual commercial wrappers as compared with unwrapped apples show that these unoiled wrappers have practically no effect upon scald control. In the tests of Table I where the two conditions were compared the average degree of scald on the wrapped apples was 41 per cent and that on the unwrapped ones 42 per cent.

UNOILED MEDICATED WRAPPERS

The unoiled medicated wrappers were purchased in the northwestern market where they have been extensively sold on the ground that they have great preservative qualities. The average results of the comparable tests in the preceding table show 33 per cent of scald on the apples in unoiled wrappers and 23 per cent on the apples in unoiled medicated wrappers.

PARAFFIN WRAPPERS

Paraffin wrapper No. 1 was made by soaking the usual commercial apple wrapper in hot paraffin; paraffin wrappers No. 2, 3, and 4 were supplied by paper companies; No. 2 was a heavy grade of paper and No. 3 and 4 tissue grades similar to the paper used for wrapping lunches and apparently infiltrated with a low melting point paraffin or a mixture of paraffin and oil.

The paraffin wrappers have reduced the percentage of scald in all cases, but have shown only about half the efficiency of the mineral oil wrappers. An average for the comparable tests shows 42 per cent of scald on the apples in unoiled commercial wrappers, 20 per cent on the apples in the paraffin wrappers and no scald for those in mineral oil wrappers.

MINERAL OIL WRAPPERS

EFFECT UPON SCALD

The scald control secured with the mineral oil wrappers is shown in detail in Table I and the relative efficiency of the various wrappers is brought out more clearly in Table II. In most cases these wrappers either entirely prevented the disease or reduced it to such an extent that it was no longer of importance from the market standpoint. In the total of 67 experiments there were four instances that probably should be noted as exceptions to this rule; two with eastern grown Stayman Winesap and two with eastern grown Arkansas (Mammoth Black Twig). In the 1921 and 1922 experiments with Stayman Winesap scald was reduced from more than 50 per cent on the unwrapped fruit to 4 to 16 per cent on the fruit in the better grade of oil wrappers. In the 1919 experiment with Arkansas scald was held in complete control by the oiled wrappers until January 10, when the unwrapped fruit showed 55 per cent of the disease, but by February 2 the apples in oiled wrappers had developed 18 to 25 per cent of scald as compared with 64 per cent on the unwrapped apples. In the 1922 experiment on Arkansas from Rockville, Md., the apples in oiled wrappers had developed about 20 per cent of scald by February 17, while those that were unwrapped had 75 per cent. These results with Stayman Winesap and Arkansas would appear to be fairly satisfactory when compared with the average data from disease-control measures, but they fall considerably short of the control secured in other oiled wrapper experiments, and in the case of the Arkansas the disease was not held sufficiently in check to prevent the apples from being offered at a discount in price.

TABLE II.—*Relative efficiency of mineral oil wrappers in the control of apple scald*

Variety of apples and date of note taking.	Percentage of scald.																									
	Check, no oil.	Mineral oil wrappers.																								
		1	1a	1b	2	3	3a	3b	4	4a	4b	4c	5	6	7	8	9	10	11	11a	11b	11c	11d	11e	11f	12	13	13a
Grimes Golden, eastern:																												
Dec. 20, 1918	27	....	0	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Jan. 13, 1920	83	0	....	0	....	0	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Feb. 3, 1921	15	....	....	....	....	0	0	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Jan. 8, 1921	66	....	....	....	....	0	....	....	0	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Jan. 19, 1922	35	....	....	....	....	....	0	....	0	....	0	30	2	0	0	....	....	....	....	....	....	....	....	....	....	....	....	....
Apr. 13, 1922	70	....	....	....	....	....	0	....	15	....	18	38	22	20	6	....	....	....	....	....	....	....	....	....	....	....	....	....
Jan. 12, 1923	49	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	3	1	0	0	0	2	2	....	1	....	....
Grimes Golden, northwestern:																												
Feb. 12, 1921—																												
Delayed storage	67	1	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Immediate storage	25	0	....	....	....	....	0	....	0	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Mar. 1, 1922—																												
Cellar storage	34	....	....	....	....	....	....	....	0	....	0	....	....	....	....	0	....	....	....	....	....	....	....	....	....	....	....	....
Cold storage	31	....	....	....	....	....	....	....	0	....	0	1	0	0	0	....	....	....	....	....	....	....	....	....	....	....	....	....
Feb. 17, 1923—																												
Cellar storage	54	....	....	....	....	....	....	....	1	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	1	....	3
Cold storage	36	....	....	....	....	....	....	....	1	....	....	....	....	1	0.5	....	....	....	....	....	....	0	....	....	0	0.4	....	0.7
York Imperial, eastern:																												
Jan. 15, 1920	70	0	....	0	0	0	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Mar. 5, 1920	.....	0	....	0	....	0	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Jan. 17, 1920	69	4	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
May 14, 1921	89	....	....	....	....	....	0	....	0	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Apr. 13, 1921	32	....	....	....	....	0	0	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
May 26, 1921	45	....	....	....	....	7	3	....	7	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Feb. 10, 1922	8	....	....	....	....	0	0	....	4	3	3	9	6	1	2	....	....	....	....	....	....	....	....	....	....	....	....	....
Jan. 29, 1923	65	....	....	....	....	....	5	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Feb. 5, 1923	45	....	....	....	....	....	0	....	....	....	....	....	....	....	....	....	....	1	0	2	....	....	....	....	....	....	0	....
Feb. 17, 1923	40	....	....	....	....	....	0	....	....	....	....	....	....	....	....	....	....	....	7	4	6	8	15	9	15	....	6	15
Feb. 26, 1923	46	....	....	....	....	....	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
York Imperial, northwestern:																												
Apr. 22, 1922	47	....	....	....	....	....	0	....	0	1	1	2	1	0	0	....	0	....	....	....	....	....	....	....	....	....	....	....
Apr. 19, 1923	51	....	....	....	....	....	....	....	1	....	....	....	....	....	1	....	....	....	0.5	1	....	0.5	....	....	....	2	0.7	....	1
Stayman Winesap, eastern:																												
Feb. 24, 1921	25	....	....	....	....	0	0	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
May 14, 1921	26	....	....	....	....	0	0	....	0	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Feb. 13, 1922	52	....	....	....	....	....	4	....	16	9	10	22	....	....	....	....	....	....	10	....	9	....	....	....	....	....	8	....
Feb. 26, 1923	53	....	....	....	....	....	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....

| | | |

A study of the data from the experiments reported in Table I, in which fruit was withdrawn at different times in the storage season, shows that the oiled wrappers have delayed scald 4 to 12 weeks on Grimes, 8 to 18 weeks on York Imperial, 10 or more weeks on Rome Beauty, 5 to 17 weeks on Stayman Winesap, and 4 to 15 weeks on Arkansas (Mammoth Black Twig). The fruit that was unwrapped or in unoiled wrappers became more seriously scalded with the advance of the storage season, while that which was in oiled wrappers usually remained practically or entirely free from scald, the apples finally breaking down from old age or some other cause. The apples in oiled wrappers were usually firmer and crisper than those in unoiled wrappers.

SOURCE AND PREPARATION OF OILED WRAPPERS

Mineral oil wrappers Nos. 1, 1a, and 1b were treated with an oil having a yellow color and a slight odor of kerosene. The oil was of paraffin origin and was purchased from an eastern oil company having large holdings in the South Central States. Wrapper No. 1 was prepared by applying hot oil to the usual 14-pound commercial apple wrappers and removing the excess of oil by stacking the oiled wrappers between unoiled ones. The final wrappers carried 17 to 25 per cent of their weight of oil. Wrappers No. 1a and 1b were supplied by a paper company; No. 1a was a very heavy grade of oiled paper and No. 1b a similar paper of medium weight, yet far too heavy for commercial apple wrapping.

Wrapper No. 2 was hand oiled, as described for No. 1 with a similar oil from the same source, but having a higher viscosity.

Wrappers No. 3, 3a, and 3b were treated with an oil that was similar to those used on Nos. 1 and 2 and of the same origin, but it had a higher specific gravity and a deeper color. Wrapper No. 3 was hand oiled, as described for No. 1. Wrapper No. 3a was a specially prepared apple wrapper purchased from an eastern paper company. See description in Table III.

Wrapper No. 3b was a specially prepared apple wrapper purchased from a western company. It was a 14-pound paper carrying 11 per cent of oil.

Wrappers Nos. 4, 4a, 4b, and 4c were treated with an odorless, tasteless, colorless oil derived from a paraffin base and refined by an eastern oil company. Wrapper No. 4 was hand oiled, as described for No. 1. Wrapper No. 4a was a special apple wrapper prepared by the same company that prepared No. 3b. It was a 14-pound paper carrying 12 per cent of oil, or about 22 grams to 100 wrappers. Wrapper No. 4b was a special apple wrapper prepared by a middle west paper company. It was a 12-pound paper carrying 14 per cent of oil, or about 23 grams to each 100 wrappers. Wrapper No. 4c was from the same company as No. 4b, but it carried only 4 per cent of oil, or about 6 grams to each 100 wrappers.

Wrapper No. 5 was hand oiled, as described for wrapper No. 1, but with an odorless, tasteless, colorless oil a little heavier than that used on wrapper No. 4 and marketed by the same oil company.

Wrapper No. 6 was hand oiled, as described for No. 1, but with an odorless, tasteless, colorless oil a little lighter than that used on wrapper No. 4, derived from a paraffin base and marketed by a middle west oil company.

Wrapper No. 7 was hand oiled, as described for No. 1, but with an odorless, tasteless, colorless oil derived from an asphalt base and marketed by a Pacific coast oil company.

Wrapper No. 8 was an oiled, medicated wrapper marketed by the same company as the unoiled medicated wrapper already described. It had been treated with the same oil that was used on wrapper No. 7 and carried 15 per cent of its weight of oil.

Wrapper No. 9 was a specially prepared wrapper sold by the same company as 3a; it had been treated with an odorless, tasteless, colorless oil combined with a small amount of paraffin and carried about 18 per cent of the two combined.

Wrapper No. 10 was apparently very similar to wrapper No. 9 but it was prepared by a middle west paper company.

Wrappers No. 11, 11a, 11b, 11c, 11d, 11e, and 11f were prepared by an eastern paper company and were treated with the same oil as wrapper No. 4. Wrapper No. 11 was from 14-pound paper, and No. 11a from 12-pound paper, both guaranteed to contain as much as 22 per cent of oil. See Table III. Wrappers 11b, 11c, 11d, 11e, and 11f were guaranteed to contain 30, 25, 20, 18, and 15 per cent of oil, respectively. They were prepared by the paper company for experimental use.

Wrapper No. 12 was prepared by a New England paper company. It was a 14-pound paper and treated with the same oil as wrapper No. 4. See Table III.

Wrappers No. 13 and 13a were prepared by the same company as wrapper No. 4b and 4c. No. 13 was a 14-pound paper carrying 24 per cent of oil and No. 13a a 12-pound paper. See Table III for oil content.

RELATIVE EFFICIENCY OF OILS

All of the oils used have given good scald control. A comparison of the results with the hand-oiled wrappers Nos. 1, 2, 3, 4, 5, 6, and 7, as shown in Table II, might suggest some slight contrast in efficiency, but perhaps not enough to be of practical importance and beyond experimental error.

DOSAGE OF OIL IN THE WRAPPER

Experiments have shown that wrappers with free oil on their surface may sometimes cause slight injury to the skin of the apple, but fortunately such excessively oiled wrappers are impractical for general use on account of the wrappers sticking together. The hand-oiled wrappers used in the previously reported experiments had from 17 to 25 per cent of oil, or practically all the paper would carry. These wrappers gave good scald control and caused no injury, but the most completely saturated ones sometimes delayed the natural yellowing of the ground color of the apples, making them appear abnormally green at the time of removal from storage. The dosage of oil in the commercial or machine-made wrappers ranged from 4 to 30 per cent. The wrappers with 4 per cent of oil have sometimes given good scald control but under severe tests have been an almost complete failure. Wrappers carrying 11 and 12 per cent of oil have given good results on western apples and fair on eastern, but where apples have been held rather late there have been indications that these wrappers had about reached their limit in scald control. Commercial wrappers carrying 15 per cent or more of oil (about 28 grams to each 100 wrappers) have given good scald control with no objectionable results.

RETENTION OF OIL BY THE WRAPPERS

A study was made of the extent to which the various oiled wrappers gave up their oil to the apples or to other objects with which they came in contact. Oil determinations were made on fresh unused wrappers, on similar wrappers after removal from apples at the end of the storage period, and on the box-liners from the same packages. Tests were also made on the freedom with which the various wrappers gave up their oil to sheets of blotting paper, the oil content of fresh wrappers being compared with that of similar wrappers that had been held between sheets of blotting paper under 10 pounds pressure for 48 hours. The oil determinations were made by petroleum ether extraction with the Soxhlet apparatus. The preliminary work was done by the writers and the results checked up and confirmed by determinations made by Dr. G. S. Jamieson and Mr. W. F. Baughman of the oil, fat, and wax laboratory, Bureau of Chemistry. All percentages are computed on the dry weight of the oiled paper. The results are reported in Table III.

TABLE III.—*Dosage of oil in the wrapper: retention of oil*

Wrappers.			Dosage of oil on fresh wrappers.		Dosage of oil after use on the apples. Gm. of oil per wrapper.		Dosage of oil after 48 hours between blotters. Gm. of oil per wrapper.		Dosage of oil in box liners after use in contact with oiled wrappers.	
Number.	Weight of paper.	Size.	Per cent.	Gm. per wrapper.	Retained.	Lost.	Retained.	Lost.	Per cent.	Gm. per box.
3a	14-lb.	10 x 10	21.3	0.4097	0.3436	0.0661	0.0620	0.3477	9.6	4.0512
11	14-lb.	10 x 10	24.4	.4481	.3875	.0606	.0763	.3718	13.6	5.2820
11a	12-lb.	10 x 10	26.3	.4356	.3638	.0718	.0687	.3669	7.7	2.7893
12	14-lb.	10 x 10	14.2	.3191	.2640	.0551	.0625	.2566	4.9	2.1016
13a	12-lb.	10 x 10	16.7	.2528	.2080	.0448	.0478	.2050	10.1	7.5750
Average				.3731	.3134	.0597	.0635	.3096		4.3598

The data reported in Table III show some contrast in the freedom with which the different wrappers gave up their oil during storage and a still greater contrast in the freedom with which they released their oil to dry blotters. A comparison of these data with that reported in Table II, however, gives little evidence of correlation between the freedom with which the wrappers released their oil and their efficiency in scald control. The average loss of oil by the wrappers during storage was approximately 0.0597 gm. per wrapper. The amount taken up by the liners varied widely but averaged 4.3598 gm. per box. With a box containing 113 apples this would mean that the liner had taken an average of 0.0386 gm. of oil from each wrapper, leaving 0.0211 gm. of the above loss to be accounted for by passage to the apples, to the box, and to other objects.

In order to obtain further evidence in regard to the action of the oil, apples were wrapped in one or more unoiled wrappers and oiled wrappers applied outside of these. The fruit was thus largely protected from the oil, yet kept in close proximity to it. The resulting scald control is shown in Table IV.

The average degree of scald reported in Table IV for the apples that were unwrapped or in unoiled wrappers is 39 per cent, and the average for the apples in oiled wrappers 2.7 per cent, while the average where one unoiled wrapper was used inside of an oiled one is 4.9 per cent, and

the average where two or three unoiled ones were used inside an oiled one is somewhat higher. The results indicate that the efficiency of the oiled wrappers in scald control was decreased by placing unoiled wrappers between them and the apples. This decrease, however, is extremely small when compared with the percentage of scald on the untreated fruit.

Oil determinations were made on the wrappers that had been used in the above experiments, and the results are reported in Table V. All percentages are based on the dry weight of the oiled paper.

TABLE IV.—*Effect of unoiled wrappers inside of oiled ones*

Variety, locality, and period of storage.	Oiled wrapper used.	Percentage of scald.					
		Unwrapped or in unoiled wrapper.	Oiled wrapper.	One oiled wrapper outside of one unoiled wrapper.	One oiled wrapper outside of two unoiled wrappers.	One oiled wrapper outside of three unoiled wrappers.	Two oiled wrappers outside of one unoiled wrapper.
Grimes Golden, Rockville, Md., Sept. 6, 1922, to Jan. 12, 1923..	No. 3a...	49	1	4	2	.....	.....
Grimes Golden, Wenatchee, Wash., Sept. 13, 1922 to Feb. 17, 1923.....	No. 13a..	36	.7	1	.....	.....	1.3
York Imperial, Arlington, Va., Sept. 12, 1922, to Jan. 29, 1923.	No. 3a...	65	5	8	18	20	.....
York Imperial, Woodside, Del., Sept. 21, 1922, to Feb. 26, 1923.	No. 13...	46	6	7	.....	.....	.....
York Imperial, Rockville, Md., Oct. 2, 1922, to Feb. 17, 1923...	No. 11...	40	0	1	.....	.....	.....
York Imperial, Wenatchee, Wash., Oct. 23, 1922, to Apr. 19, 1923.....	No. 4....	51	1	5	.....	.....	.....
Stayman Winesap, Woodside, Del., Sept. 28, 1922, to Feb. 26, 1923.....	No. 3a...	53	2	6	.....	.....	.....
	No. 11...	53	10	18	.....	.....	.....
Stayman Winesap, Wenatchee, Wash., Oct. 25, 1922, to Mar. 17, 1923.....	No. 12...	14	0	0	.....	.....	0
Rome Beauty, Wenatchee., Wash., Oct. 10, 1922, to May 25, 1923.....	No. 13...	10	4	4	.....	.....	15
White Pearmain, Wenatchee, Wash., Oct. 12, 1922, to Apr. 3, 1923.....	No. 13a..	12	0	0	.....	.....	0
Average results.....	.....	39	2.7	4.9	.....	.....	.....

The fresh oiled wrappers averaged 0.3574 gm. of oil per wrapper and those that had been used outside of one unoiled wrapper averaged 0.2539 gm. per wrapper, making an average loss during storage of 0.1035 gm. per wrapper. Of this loss, 0.0678 gm. passed over to the unoiled wrappers, and if the movement to the liners was approximately as great as where single wrappers were used the remaining 0.0357 gm. is fully accounted for in loss to the liners. In the experiments where two unoiled wrappers were used inside the oiled one the fresh oiled wrappers had 0.4097 gm. of oil per wrapper, the used ones 0.3062 gm, and the unoiled ones after use a total of 0.0836 gm., leaving but 0.0199

gm. loss from each set of wrappers. This loss can be fully accounted for, as explained above, in passage of oil to the liners. There was no indication of oil on the apples, and if any passed over to them in either set of experiments it must have been the merest trace.

TABLE V.—*Dosage of oil in the various wrappers before and after use in experiments reported in Table IV*

Make of oiled wrapper.	Gm. of oil in fresh wrapper.	Two unoiled wrappers inside of an oiled wrapper. Gm. of oil per wrapper after use.			One unoiled wrapper inside of an oiled one. Gm. of oil per wrapper after use.	
		Oiled wrapper.	Unoiled wrapper next to oiled one.	Unoiled wrapper next to apple.	Oiled wrapper.	Unoiled wrapper.
3a	0.4097	0.3062	0.0608	0.0228	0.3181	0.0694
11	.4481	.....	.....	.....	.2860	.1038
12	.3191	.....	.....	.....	.2441	.0355
13d	.2528	.....	.....	.....	.1673	.0624
Average results....	.3574	.....	.....	.....	.2539	.0678

EFFECT OF OILED WRAPPERS ON UNWRAPPED FRUIT OF THE SAME PACKAGE

In a number of experiments only a part of the apples of the package were in oiled wrappers, the others being held either unwrapped or in unoiled wrappers. Table VI shows the scald control secured under these conditions. The eastern apples were packed in barrels with part of the apples unwrapped and the northwestern ones in boxes with part of the apples in oiled wrappers and part in unoiled ones.

TABLE VI.—*Partial control of scald on apples that were unwrapped or in unoiled wrappers but packed with apples that were in oiled wrappers*

Variety, locality, and the date of taking notes.	Percentage of scald.			
	In package with no oil.	In packages with part of the apples in oiled wrappers.		
		Apples two or more layers distant from oiled wrappers.	Apples adjacent to oiled wrappers.	Apples in oiled wrappers.
EASTERN APPLES.				
Grimes Golden:				
Jan. 20, 1919	38	20	12	0
Jan 13, 1920	70	52	21	0
Arkansas, Jan. 10, 1920	55	.....	15	1
York Imperial, Jan. 15, 1920	70	46	.....	0
NORTHWESTERN APPLES.				
Grimes Golden, Jan. 17, 1923	38	18	4	1
Stayman Winesap, Mar. 19, 1923	11	13	2	0
Average	47	29.8	10.8	0.3

The data reported in Table VI indicate that when part of the apples of a package are in oiled wrappers and part unwrapped or in unoiled wrappers, the oiled wrappers cause a very definite decrease in scald on the adjacent apples and have a favorable effect on the ones that are several layers away.

OIL WITHOUT THE WRAPPER

Experiments were made in which oiled blotter material was cut into narrow strips and scattered through the barrel of apples. Seven large blotter sheets carrying approximately 700 gm. of oil were used in each barrel. A description of the different oils has already been given in connection with the wrappers having the corresponding numbers. The results of the experiments are reported in Table VII.

TABLE VII.—*Effect of oiled blotter strips on apple scald*

Variety of apple and date of note taking.	Percentage of scald.			
	In barrels with no oil.	In barrels with oiled blotter strips.		
		Oil No. 1.	Oil No. 2.	Oil No. 3.
Grimes Golden, Dec. 31, 1919	64	26	28	21
York Imperial:				
Jan. 15, 1920	70	5	16	.....
Jan. 17, 1920	74	.....	.....	12
Arkansas, Jan. 10, 1920	55	32	.....	.....

The fruit packed with the oiled blotter material scattered through the barrel averaged about one-third as much scald as that packed in the usual manner. While the results are not particularly satisfactory from the commercial standpoint, they show that scald can be reduced without inclosing the apples in wrappers.

Experiments were also made in which barrels were soaked in oil and others in which barrels were lined with oiled blotter sheets. In both cases the scald was reduced on the fruit nearest the oil but the results in general were even less satisfactory than those reported in Table VII for the oiled blotter strips.

A large number of experiments were made in the application of oil and wax directly to the skin of the apple. The material was rubbed on with a piece of cloth at the time the apples were packed. A description of the different oils has already been given in connection with the wrappers having the corresponding numbers. The heavily oiled apples received approximately 0.06 gm. of oil to the apple, the medium oiled ones approximately 0.03 gm. and the lightly oiled ones 0.017 gm. The B1 wax was composed of 75 parts by weight of mineral oil and 25 parts beeswax, the B2 of 50 parts mineral oil and 50 parts beeswax, and the B3 of 25 parts mineral oil and 75 parts beeswax. These waxes were applied at the rate of approximately 0.04 gm. to the apple. The P wax was composed of mineral oil and hard paraffin in equal parts by weight, and the treated fruit received approximately 0.035 gm. per apple. The V wax was composed of mineral oil and vaseline in equal parts by weight, and it was applied at the rate of approximately 0.03 gm. per apple. The BP1 wax

TABLE VIII.—*Partial control of scald by means of oils and waxes applied directly to the apple*

Variety and date of note taking.	Percentage of scald.																								
			With oils.															With waxes.							
			No. 1.			No. 3.			No. 4.			No. 5.		No. 6.		No. 7.										
	No treatment.	Mineral-oil wrappers.	Heavy.	Medium.	Light.	Heavy.	Medium.	Light.	Heavy.	Medium.	Light.	Heavy.	Light	Heavy.	Light.	Heavy.	Light.	B1.	B2	B3.	P.	V.	BP1.	BP2.	BP3.
Grimes Golden, Jan. 8, 1921	45	0	20	.....	42	3	.....	15	18	.....	52	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Grimes Golden, Mar. 30, 1921	87	0	29	.....	30	.....	.....	.....	42	.....	31	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Grimes Golden, Jan. 19, 1922	35	0	.....	.....	.....	.....	.....	.....	12	.....	.....	31	.....	12	.....	8	.....	.....	24	.....	4	8	.....	.....	.....
Grimes Golden, Jan. 12, 1923	52	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	42	.....	45
York Imperial, Apr. 13, 1921	58	0	7	.....	.....	3	3	5	7	9	13	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
York Imperial, Feb. 10, 1922	16	0	0	.....	.....	.....	.....	.....	1	.....	4	3	1	1	1	0	3	6	5	2	1	1	.....	.....	.....
York Imperial, Mar. 29, 1922	10	0	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	3	.....	.....	5	4	.....	8	.....	.....	.....	.....	.....	.....
York Imperial, Jan. 29, 1923	65	5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	31	.....	.....
York Imperial, Feb. 17, 1923	40	■	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6	15	20
York Imperial, Feb. 26, 1923	46	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	37	37	42
Stayman Winesap, Feb. 24, 1921	25	■	.....	.....	.....	.....	.....	.....	8	.....	5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Stayman Winesap, Mar. 5, 1921	25	0	.....	5	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Stayman Winesap, May 23, 1921	16	0	.....	6	.....	.....	.....	.....	.....	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Stayman Winesap, Feb. 13, 1922	52	4	.....	.....	.....	.....	.....	.....	15	.....	28	.....	.....	8	25	.....	.....	15	8	7	.....	.....	18	11	10
Stayman Winesap, Feb. 26, 1923	53	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Baldwin, Mar. 29, 1922	16	1	.....	.....	.....	.....	.....	.....	2	.....	2	.....	.....	.....	.....	.....	.....	1	5	.....	.....	.....	.....	.....	.....
Rome Beauty, May 18, 1921	30	■	.....	5	.....	.....	.....	.....	.....	4	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Arkansas, Jan. 24, 1921	32	0	.....	.....	.....	3	2	10	2	2	5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Arkansas, Feb. 24, 1921	45	0	.....	.....	.....	3	.....	4	3	.....	19	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Arkansas, May 17, 1921	23	0	.....	18	.....	.....	.....	.....	.....	20	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Arkansas, May 26, 1921	72	1	.....	.....	.....	23	.....	25	28	.....	59	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	30	26	21
Arkansas, Feb. 17, 1923	75	18	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	70	63	74
Arkansas, Feb. 21, 1923	70	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Arkansas Black, June 20, 1921	9	0	.....	19	.....	.....	.....	.....	.....	8	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Rhode Island Greening, Mar. 29, 1922	28	0	.....	.....	.....	.....	.....	.....	1	.....	1	.....	.....	.....	.....	4	.....	0	4	.....	.....	.....	.....	.....	.....

was composed of 40 parts by weight of mineral oil, 5 parts beeswax, and 55 parts paraffin. The BP2 wax was composed of 40 parts of mineral oil, 10 parts beeswax, and 50 parts paraffin. The BP3 wax was composed of 29 parts mineral oil, 10 parts beeswax, and 61 parts paraffin. Approximately 0.018 gm. of the beeswax-paraffin-oil mixtures was applied to each apple. The relatively low dosage in this case was due to the fact that these waxes were comparatively firm and did not stick to the fruit in as heavy layers as the other waxes. The results of the various oil and wax experiments are reported in Table VIII.

In most cases the apples that were treated with oil had a less attractive appearance upon removal from storage than the untreated ones. The natural bloom of the fruit was lacking, and the apples that had received heavy or medium applications of oil, and many of them that had received light ones, still had an oily appearance. The apples that received the beeswax-oil, paraffin-oil, or vaseline-oil mixtures were usually slightly sticky or greasy, but those that received the beeswax-paraffin-oil combinations had little that was objectionable in feel or appearance.

Many of the lots treated with oil and a few of those treated with beeswax-oil mixtures had a higher percentage of blue mold rot than the untreated fruit.

Most of the apples that were treated with either oil or wax were much greener and firmer than the untreated fruit and were often lacking in flavor and quality. The condition of the fruit was much like that described in an earlier publication [3] as resulting from short periods of storage in carbon dioxide. The fruit that received heavy or medium applications of oil was affected most, that which received light applications of oil or was treated with beeswax-oil, paraffin-oil, or vaselin-oil mixtures was less affected, while that which was treated with the beeswax-paraffin-oil mixtures was entirely normal in color, firmness, and taste.

A study of Table VIII shows that all of the oils and most of the waxes decreased the development of scald but that they fell far short of the oiled wrappers in efficiency. If an average is taken of the comparable tests, it gives 14.7 per cent of scald on the lightly oiled apples, 9.1 per cent on the heavily oiled ones, 40.5 per cent on the untreated fruit, and 0.5 per cent on the apples in mineral-oil wrappers. The beeswax-oil, paraffin-oil, and vaseline-oil mixtures gave approximately as good results as the heavy applications of oil, but the beeswax-paraffin-oil mixtures had little or no value in scald control. As already noted, the beeswax-paraffin-oil mixtures not only had a low oil content but also were applied to the apples in much smaller quantities than the other materials. The poor scald control secured with these mixtures and the contrasts in control with the heavy and light applications of oil indicate a correlation between quantity of oil applied and degree of efficiency in scald control.

NATURE OF SCALD CONTROL

Investigations in regard to the general nature of apple scald were reported in an earlier publication.[3] It was established by experimental data that in so far as the usual storage conditions were concerned scald was the result of tight packages and tight storing and that the disease could be prevented by free air movement over the apples. It was shown that while tight storage naturally resulted in a decrease in the oxygen

[3] Brooks, Charles, Cooley J. S., and Fisher, D. F. op. cit.

and an increase in the carbon dioxid present in the storage air, these conditions were not responsible for the development of scald and, in fact, that increases in the carbon-dioxid content of the air actually tended to hold the disease in check. Experiments on humidity indicated that the benefits from air currents probably could not be attributed to their drying effect. Withered apples usually scalded less than crisp ones but apparently because of the aeration that accompanied the drying rather than from the drying itself. Apples stored in the air that was saturated with moisture but constantly stirred did not develop scald while similar apples in dry, stagnant air became badly scalded. The negative results along the above lines finally led to testing the effects of the odorous products of the apple. It was found that typical scald conditions could be produced by exposing the apples to odorous substances similar to those given off by the apples and that various odor-absorbing materials such as fats and oils could be used as scald preventives. These facts gave the foundation for the development of the oiled wrapper.

The data of the present paper furnish additional evidence in regard to the factors involved in scald control. That the question of humidity is secondary or negligible is indicated by the fact that the tin foil and glassine wrappers (see Table I) had little or no effect upon scald, by the fact that the paraffin wrappers had less than half the efficiency of the mineral oil wrappers, and also by the fact that the oiled and waxed apples although still oily and sticky at the time of removal from storage were not protected from scald to anything like the degree that prevailed with the apples held in oiled wrappers. In these various tests there was apparently no correlation between moisture control and scald control.

It was stated above that increases in the carbon-dioxid content of the storage air resulted in a decrease in apple scald. The oiled wrappers and the direct oil and wax treatments tend to restrict the free air movement between the apple tissues and the outside air and would favor the accumulation of the carbon-dioxid of respiration in the air within and immediately surrounding the apple. It would therefore seem possible that their value in scald control might be due to this restriction of gaseous exchange. This can not be true, however, in so far as the direct physical protection of the oiled wrapper is concerned, for if this were the case the glassine wrapper, which is made of practically air-tight paper, should give better scald control than the oiled wrapper, the paraffin wrapper should give practically as good control, and double and triple wrapped apples should have greater freedom from scald than single wrapped ones, all of which conditions are contrary to the facts. If the oiled wrapper is of value on account of physical barriers set up, it must be through the coating of oil it deposits on the apple.

With the oil and wax treatments of the apple and with the film of oil that passes over from the wrapper to the apple there is the possibility both of restriction in gaseous exchange and of more direct physiological effects upon the skin of the apple. That a definite physiological effect is produced is evidenced by the fact that the development of yellow in the ground color of the apple is delayed by both methods of treatment and approximately in proportion to the amount of oil that is deposited on the apple. It would seem probable that any agency that had a checking or inhibiting effect upon the skin of the apple might at the same time be responsible for a reduction in scald, but it does not seem possible to fully explain the scald control secured with the oiled wrapper on this

basis. The scald control secured with the direct applications has been approximately in proportion to the amount of oil used and in proportion to the inhibition of coloring, but the scald control secured with the oiled wrapper has been entirly out of proportion to the amount of oil deposited on the apples and out of proportion to the inhibition of color development in the skin. The direct application of 0.017 gm. of oil per apple has reduced scald from 40.5 per cent to 14.7 per cent (see Table VIII and discussion), and the direct application 0.06 gm. per apple has reduced the disease to 9.1 per cent; while the use of oiled wrappers with a deposit of less than 0.0211 gm. of oil per apple (see Table III and discussion) has reduced scald to 0.5 per cent. The results of the various investigations on scald have shown that the elimination of the last 10 or 15 per cent of the disease is far more difficult than similar reductions from higher percentages; and it seems impossible to explain the extreme efficiency of the oiled wrapper on the basis of the small deposit of oil on the apple. The evidence at hand seems to justify the conclusion that the inhibition of coloring in the skin of the apple is due to the oil actually deposited on it, but that the scald control is determined by the total oil lying in close proximity to the apple but not necessarily deposited on it.

This theory of scald control receives further support from the fact that the disease has been greatly reduced on apples that were unwrapped or in unoiled wrappers, but adjacent to apples in oiled wrappers, and slightly reduced on similar apples that were two or more layers distant from the oiled wrappers (Table VI), and also by the fact that apples with an unoiled wrapper inside the oiled one and with apparently no deposit of oil on the apples have had but little more scald than those with the oiled wrapper in direct contact with the skin of the apple.

CRITICAL PERIODS IN THE DEVELOPMENT OF SCALD

The oiled wrapper has furnished a convenient means of determining the period in the storage season in which the different varieties of apples need the greatest protection against scald. Table IX shows the results obtained by applying the oiled wrappers at different times; in some cases at picking time and in others several weeks after the apples had been placed in storage.

The results show that it is not essential to scald control that the wrappers applied at picking time should remain on the fruit throughout the storage season. In one experiment Rome Beauty apples remained free from scald when the oiled wrappers were removed at the end of 4 weeks of storage, and in another they scalded when they were removed at the end of 5 weeks but not when removed at the end of 10 weeks. Stayman Winesap scalded when the oiled wrappers were removed at the end of 6 weeks, but remained free from scald when removed at the end of 9 weeks. Winesap remained free from scald when the wrappers were removed at the end of 8 weeks, while Grimes Golden scalded badly when the wrappers were removed at the end of 9 weeks.

Oiled wrappers applied during the first month of storage gave as complete scald control on all varieties as those applied at picking time; those applied at the end of 8 weeks gave only partial control on Arkansas, York Imperial, and Stayman Winesap, while those applied at the end of 12 weeks of storage gave complete control on Rome Beauty and Winesap.

TABLE IX.—*Critical periods in the development of apple scald as shown by the results from oiled wrappers applied at different times in the storage season*

Description of apples and wrappers.	Wrappers applied.	Degree of scald manifest after storage.
		Per cent.
Grimes Golden, Rockville, Md.; picked Sept. 3, 1920; notes taken Jan. 8, 1921:		
Unoiled wrappers	At picking time	66
Mineral oil wrapper No. 3	do	0
Do	Nov. 3, 1920	0
Do	Nov. 23, 1920	2
Do	Dec. 10, 1920	54
Grimes Golden, Wenatchee, Wash.; picked Sept. 20, 1920; notes taken Feb. 12, 1921:		
Unoiled wrapper	At picking time	25
Mineral oil wrapper No. 3a	do	0
From unoiled wrapper applied at picking time to No. 3a	Oct. 27, 1920	0
Do	Nov. 11, 1920	0
Do	Nov. 26, 1920	1
Grimes Golden, Wenatchee, Wash.; picked Sept. 19, 1921; notes taken Mar. 1, 1922:		
Unoiled wrapper	At picking time	31
Mineral oil wrapper No. 4b	do	0
From unoiled wrapper applied at picking time to No. 4b	Oct. 3, 1921	0
Do	Oct. 21, 1921	0
Do	Nov. 21, 1921	0
From mineral oil wrapper No. 4b applied at picking time to unoiled wrappers	Oct. 3, 1921	24
Do	Oct. 21, 1921	17
Do	Nov. 21, 1921	24
York Imperial, Arlington, Va.; picked Sept. 27, 1920; notes taken Apr. 3, 1921:		
Unoiled wrapper	At picking time	32
Mineral oil wrapper No. 3	do	0
Do	Nov. 3, 1920	5
Do	Nov. 23, 1920	18
Arkansas (Mammoth Black Twig), Winchester, Va.; picked Oct. 18, 1920; notes taken Jan. 24, 1921:		
Unwrapped		42
Mineral oil wrapper No. 3	Nov. 11, 1920	2
Do	Dec. 15, 1920	22
Do	Dec. 28, 1920	35
Mineral oil wrapper No. 3a	Nov. 11, 1920	3
Do	Dec. 15, 1920	23
Rome Beauty, Wenatchee, Wash.; picked Oct. 20, 1920; notes taken May 18, 1921:		
Unoiled wrapper	At picking time	30
Mineral oil wrapper No. 3a	do	0
From unoiled wrapper applied at picking time to No. 3a	Nov. 20, 1920	0
Do	Dec. 20, 1920	0
Do	Jan. 21, 1921	0
Do	Feb. 25, 1921	11
From mineral oil wrapper No. 3a applied at picking time to unoiled wrapper	Nov. 20, 1920	0
Do	Dec. 20, 1920	0
Do	Jan. 21, 1921	0
Do	Feb. 25, 1921	0
Rome Beauty, Wenatchee, Wash., picked Oct. 27, 1921; notes taken Apr. 22, 1922:		
Unoiled wrapper	At picking time	22
Mineral oil wrapper No. 4a	do	0

TABLE IX.—*Critical periods in the development of apple scald as shown by results from oiled wrappers applied at different times in storage season*—Continued

Description of apples and wrappers.	Wrappers applied.	Degree of scald manifest after storage.
Rome Beauty, Wenatchee, Wash., etc.—Continued.		
Unoiled wrapper applied at picking time and removed and replaced	Dec. 1, 1921	Per cent. 24
Do	Jan. 2, 1922	15
From unoiled wrapper applied at picking time to No. 4a	Dec. 1, 1921	0
Do	Jan. 2, 1922	2
From mineral oil wrapper No. 4a applied at picking time to unoiled wrapper	Dec. 1, 1921	7
Do	Jan. 2, 1922	0
Stayman Winesap, Wenatchee, Wash.; picked Oct. 9, 1920; notes taken May 23, 1921:		
Unoiled wrapper	At picking time	16
Mineral oil wrapper No. 3a	do	0
From unoiled wrapper applied at picking time to No. 3a	Nov. 20, 1920	0
Do	Dec. 8, 1920	11
Do	Jan. 10, 1921	3
Do	Feb. 25, 1921	7
From mineral oil wrapper No. 3a applied at picking time to unoiled wrapper	Nov. 20, 1920	3
Do	Dec. 8, 1920	0
Do	Jan. 10, 1921	0
Do	Feb. 25, 1921	0
Winesap, Wenatchee, Wash.; picked Oct. 25, 1920; notes taken June 20, 1921:		
Unoiled wrapper	At picking time	9
Mineral oil wrapper No. 3a	do	0
From unoiled wrapper applied at picking time to No. 3a	Dec. 20, 1920	0
Do	Jan. 21, 1921	1
Do	Feb. 25, 1921	2
Do	Apr. 4, 1921	4
From mineral oil wrapper No. 3a applied at picking time to unoiled wrapper	Dec. 20, 1920	0
Do	Jan. 21, 1921	0
Do	Feb. 25, 1921	0
Do	Apr. 4, 1921	0

All of the repacking was done in the cold storage rooms, and it was not believed that the apples received enough aeration during the exchange of wrappers to materially influence the development of scald, but this point was definitely tested with one lot of Rome Beauty. The unoiled wrappers were removed and the apples repacked in the same wrappers without securing scald control, while similar apples repacked in oiled wrappers were free from scald at the end of the storage period.

The results of the experiments reported in Table IX have a practical value in showing that where apples are stored in orchard boxes and packed out later, the oiled wrappers can still be used to advantage in scald control. They are of general pathological interest because of the light they throw on the cumulative nature of a physiological disease, and they are in agreement with the experiments on aeration reported in earlier publications in showing that the development of scald can be divided into several fairly distinct periods or stages.

The first period in the development of apple scald begins with the picking of the fruit and, with the more susceptible varieties, ends with

the sixth or eighth week of storage. During this time the scald-producing agencies are apparently most active, yet up to the end of the period it is possible to largely or entirely overcome any accumulated tendencies to the disease by wrapping the apples in oiled paper or by airing them out in a warm room. The second stage in the development of the disease extends over a 5 to 8 week period following the first. Preventive measures have now become of little or no avail. The apples are doomed to scald if given sufficient time, yet if removed from storage before the end of the period they do not show scald even upon warming. The third stage or period covers the remainder of the time the apples are in storage. They have now become latently or potentially scalded. Certain skin cells are practically dead, yet will remain green and appear practically normal if not exposed to warm air. The fourth stage includes the life of the scalded apples after removal from storage. The affected skin turns brown and completes its death processes.

SUMMARY

The results are reported on 67 different apple storage experiments carried out under commercial storage conditions.

Apples packed in the usual unoiled wrappers have had practically the same degree of scald as those that were unwrapped.

Paraffin wrappers have caused considerable reduction in the prevalence of scald, but have proved far inferior to oiled wrappers.

In 63 of the 67 tests the oiled wrappers have either entirely prevented the development of scald or reduced it to a degree that made it negligible from the commercial standpoint. The apples in oiled wrappers have shown but little if any delay in coloring and have been entirely normal in taste and appearance.

Wrappers carrying less than 15 per cent of oil have been less efficient in scald control than those carrying 15 per cent (about 0.28 gm. per wrapper) or more of oil.

Seven different mineral oils have been tested in the oiled wrappers and all have been efficient in scald control.

Oiled blotter material scattered through the barrel package has reduced scald to about one-third the amount found in the untreated barrels.

Oils and mixtures of oils and waxes applied to the skin of the apple have given rather erratic results in scald control, the efficiency of the treatment usually varying with the amount of oil applied. The apples have usually had a greasy appearance and an abnormal greenness, sometimes accompanied by a lack of flavor and a general condition of the fruit similar to that resulting from storage in high percentages of carbon dioxid.

Various oil determinations are reported, giving the amount of oil in the fresh wrappers and in the used ones, the amount taken up by box liners; and the amount taken up by unoiled wrappers applied to the apples inside the oiled ones.

The conclusion is drawn that the checking of the changes from green to yellow in the skin of the apple is due to the oil actually deposited on the apple, and that the extent of the scald control is largely determined by the amount of oil in close proximity to the skin of the apple but not necessarily deposited on it.

Four stages, or periods, are recognized in the development of scald, each bearing a different relation to remedial measures.

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